Clinical Medicine 25 (2025) 100327

Contents lists available at ScienceDirect

Clinical Medicine

journal homepage: https://www.sciencedirect.com/journal/clinical-medicine

CME: Respiratory Medicine

Pneumothorax: An update on clinical spectrum, diagnosis and management ☆

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ARTICLE INFO

Keywords:
Pneumothorax
Classification
Diagnosis
Management

ABSTRACT

Pneumothorax is defined as air in the pleural space and is characterised by chest pain and breathlessness. It is commonly divided into spontaneous and non-spontaneous subtypes based on the underlying mechanism. Chest X-ray is the most common investigation to diagnose and monitor pneumothorax, but CT-chest is being increasingly used to aid decision making in complex cases and to investigate an underlying lung disease. There should be a low threshold to investigate for an underlying familial or catamenial cause in suspected cases. Treatment for pneumothorax is based on clinical condition and symptoms of the patient rather than the size of pneumothorax. Conservative care can be offered to minimally symptomatic primary spontaneous pneumothorax patients, while needle aspiration, ambulatory Heimlich valve device and chest drain remain the interventional treatment options. Chest drain is a common treatment for patients with secondary spontaneous pneumothorax due to poor lung reserve. Recurrence after spontaneous pneumothorax is common and smoking cessation reduces the risk of future recurrence in active smokers. Surgical treatment with pleurodesis ± bullectomy should be considered for treatment of suitable patients with persistent air leak and for pneumothorax recurrence prevention in high-risk populations.

Introduction

Pneumothorax is a collection of air in the pleural space, ie between the lung and chest wall. It is a common medical problem that is frequently encountered in clinical practice. Recent high-quality clinical trials have shaped our current understanding of the management of pneumothorax, challenging the age-old wisdom of treating the chest X-ray rather than the patient. In this article, we will provide a brief overview of pneumothorax with a key focus on the updates in the current management approach for pneumothorax.

Pneumothorax: types and characteristics

Pneumothorax is mainly classified into spontaneous and non-spontaneous types, where spontaneous pneumothorax (SP) occurs without any known cause or injury.[1] Fig. 1 provides an overview of the common classification of pneumothorax.

Clinically, patients with pneumothorax usually present with a sudden-onset chest pain and/or breathlessness. There can be a precipitating factor in SP, eg chest infection, lifting a heavy weight, excessive coughing or playing a wind instrument, but usually they occur 'out of the blue'.[1] Symptomatic patients often require a treatment to drain the air collection. The specific characteristics of common types of pneumothorax are summarised in Table 1.

A) Diagnostic investigations for pneumothorax

Imaging

Chest X-ray (CXR) is the most common investigation to diagnose and monitor pneumothorax. It provides useful information about the size and location of pneumothorax, any underlying lung disease, associated subcutaneous emphysema and the position of the chest drain (if inserted).

A computed tomorgraphy (CT) chest is being increasingly performed in patients with pneumothorax. This is particularly useful in complex

☆ This article has an accompanying continuing medical education (CME) activity. Completion of this CME activity enables RCP members to earn two external CPD credits. The CME questions are available at: https://cme.rcp.ac.uk/.

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https://doi.org/10.1016/j.clinme.2025.100327
Received 11 March 2025; Received in revised form 5 May 2025; Accepted 6 May 2025
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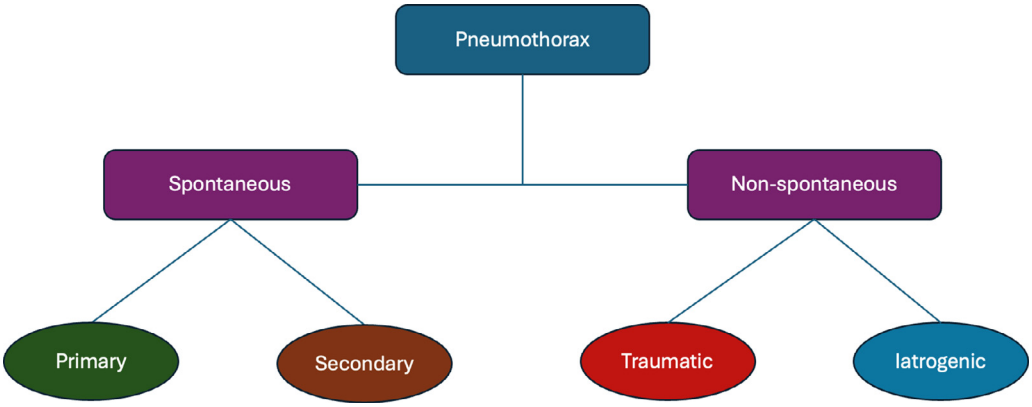

Fig. 1. Classification of pneumothorax.

Table 1
Summary of clinical characteristics of pneumothorax sub-types.

Type of pneumothorax	Cause	Incidence	Treatment options
Primary spontaneous (PSP)[2]	Usually unknown, 10 % of cases are familial	14.1 admission per million population (60 % of cases are SSP)	Conservative, NA, CD, HV device
Secondary spontaneous (SSP)	Lung disease, eg COPD, ILD, cystic fibrosis, COVID-19		Usually requires CD
Traumatic[3]	Penetrating or blunt trauma to the chest	~4 million cases globally	Usually treated with large bore CD
Iatrogenic[4–8]	Medical interventions, eg lung biopsy and ablation, cardiac pacemaker, central vein catheterisation	Combined incidence unknown CT-guided lung biopsy (~26 %, reported up to 61 %) Lung ablation (16–52 %) Pacemaker and central venous catheters (<1 %)	Mostly managed conservatively, rest are managed with CD (~7 % after lung biopsy)
Catamenial[9,10]	Thoracic endometrial deposits, predominantly on pleural surface, symptoms coinciding with menstruation, type of SSP	~80 % of patients with thoracic endometriosis	Usually requires CD Treatment with GnRH analogues
Barotrauma[11]	Mechanical ventilation, type of iatrogenic pneumothorax	Variable (3–10 % based on the underlying disease)	Usually requires CD
Pneumothorax ex vacuo (non-expandible lung)[12]	Thickening of visceral pleura due to inflammation, malignancy, infection preventing lung re-expansion	20–30 % of malignant pleural effusion cases	Does not require drainage

COPD, chronic obstructive pulmonary disease; ILD, interstitial lung disease; NA, needle aspiration; CD, chest drain; HV, Heimlich valve; GnRH, gonadotrophin-releasing hormone.

pneumothorax, ie with a tethered lung or bullous lung disease in SSP to delineate the pneumothorax and to perform drainage under CT guidance if non-guided percutaneous drainage is deemed high risk. It is also used to investigate cases with a suspected familial cause of PSP, eg cystic lung disease due to lymphangioleiomyomatosis (LAM) in females or in Birt–Hogg–Dubé syndrome.[1]

A magnetic resonance imaging (MRI) thorax can be helpful in investigating endometrial deposits in suspected catamenial pneumothorax in up to 83 % of cases,[13] especially if performed during menstruation.

B) Management of pneumothorax

The aim of drainage of pneumothorax is to restore intrathoracic physiology while the lung heals on its own. Hence, every pneumothorax does not require drainage and there is now a paradigm shift in the management of pneumothorax. The 2023 British Thoracic Society (BTS) Pleural Disease Guidelines recommend patient symptoms and clinical condition as decisive factors in the treatment of pneumothorax (rather than the historically practised approach based on the size of the pneumothorax).[14,15]

Acute management

1. Clinically unstable patient
   The most important factor in the acute management of pneumothorax is the clinical stability of the patient. If there are concerns of clinical deterioration, urgent chest drainage is required. Table 2 shows a list of all features that are considered high risk for clinical deterioration and should be treated urgently.

Table 2
High-risk characteristics for pneumothorax (adapted from the BTS guidelines).

High-risk characteristics for clinical deterioration
1. Tension pneumothorax (clinical instability)
2. >50 years of age with significant smoking history (ie >20 pack years)
3. Known underlying lung disease
4. Significant hypoxia
5. Bilateral pneumothorax
6. Haemopneumothorax

2. Minimally symptomatic patient
   For PSP patients with minimal/no symptoms, a recent trial by Brown *et al* has demonstrated that conservative care (ie no drainage and monitoring only) is non-inferior to chest drain for radiological resolution of pneumothorax in 8 weeks, irrespective of the size of pneumothorax.[16] Based on this evidence, the BTS Guidelines now recommend that asymptomatic PSP patients can be safely managed with a conservative approach. A good practice point is to monitor these patients in the department for 2–4 h before discharge. For SSP patients with small pneumothorax, inpatient monitoring for 24 h or overnight is recommended to ensure clinical stability. A regular outpatient follow-up with CXR can be performed every few days until

full resolution of pneumothorax. A clear safety net advice should be provided to return to hospital in case of worsening symptoms.

3. Clinically stable symptomatic patient
   For symptomatic patients with a sizeable PSP, treatment options include needle aspiration, chest drain with inpatient admission and ambulatory Heimlich valve device. There is limited evidence of the safety of conservative care in this patient group; a current UK-wide trial (CONSEPT) is addressing this question by comparing conservative to interventional care in PSP patients.
   - Needle aspiration could be offered to patients who prefer quick symptom relief without hospital admission. A repeat procedure might be required in up to 50 % of cases and this should be clearly discussed with the patient.
   - An ambulatory Heimlich valve device can lead to a significant reduction in the length of stay in hospital compared to chest drain with a slight increase in adverse events, as demonstrated by the RAMPP trial.[17] Hence ambulatory care could be considered for patients who prefer short-term drainage without hospitalisation, provided there are adequate follow-up services available in the hospital.
   - A chest drain with inpatient admission is recommended if the priority is quick symptom relief and avoidance of multiple procedures.

   Patients with SSP fulfil the high-risk characteristics (Table 2), with a high likelihood of decompensation or poor outcomes, so clinicians should have a low threshold for chest drain insertion and admission to hospital. It is pertinent to mention that not all SSP patients are >50 years of age and with a known underlying lung disease so a high index of suspicion is required to identify and treat these patients, eg young cannabis smokers with a significant lung damage might not have a formal diagnosis of COPD, but they should be treated as SSP.

Patients with persistent air leak (PAL)

PAL is defined as a pneumothorax with active air leak after 3–5 days of chest drain insertion. Patients with PAL who are clinically fit should have an early discussion with thoracic surgeons to consider surgical treatment. If a patient is not fit for surgery, like frail SSP patients, an autologous blood patch (ABP) could be attempted, but success rate varies from <50 % to 91 %.[18] Based on local expertise, an endobronchial valve or long-term ambulatory drainage can be considered on a case-by-case basis.

Role of surgery

Surgical treatment, ie pleurodesis with bullectomy or bullectomy alone, is considered a definitive treatment for pneumothorax. Referral to surgery after the first episode of pneumothorax is usually not recommended, but if a patient's strong priority is recurrence prevention, they should be referred to surgeons after the first episode. Below is a summary of common indications for surgical referrals.

During the episode of pneumothorax:

- persistent air leak
- first pneumothorax presenting with tension pneumothorax
- synchronous bilateral pneumothorax.

Elective procedure after pneumothorax resolution:

- second ipsilateral pneumothorax
- first contralateral pneumothorax
- high-risk occupations, eg airline pilots, deep sea divers, military personnel.

Post-pneumothorax care

PSP can recur in about 32 % of cases and the risk of recurrence is reduced by fourfold in patients who quit smoking.[19] Hence, every patient with pneumothorax should be offered smoking cessation advice. Patients can fly after 7 days of full resolution of pneumothorax. Scuba diving is a lifelong contraindication after pneumothorax unless a definite recurrence prevention surgery has been undertaken.[14]

Genetic testing for familial causes of pneumothorax:

Familial causes can be found in around 10 % of PSP cases. Genetic testing is available for Birt–Hogg–Dubé (FLCN gene), LAM (TSC1&2) and Marfan syndrome (FBN1).[1] Suspected patients can be referred to the national familial pneumothorax service for specific investigations and treatment https://www.cuh.nhs.uk/our-services/rare-disease-collaborative-network-familial-pneumothorax/.

Conclusion

In summary, the management of pneumothorax is evolving from the 'one-size-fits-all' method based on pneumothorax size to more personalised care focused on patient symptoms. Persistent air leak in pneumothorax continues to pose a management challenge and robust research is needed to explore better treatment options. Smoking cessation remains important for recurrence prevention in pneumothorax and should be strongly encouraged.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Beenish Iqbal: Writing – original draft, Conceptualization. **Rob Hallifax:** Writing – review & editing, Supervision. **Najib M. Rahman:** Writing – review & editing, Supervision.

References

1. Iqbal B. Hallifax R. Pneumothorax. *Medicine (Baltimore)*. 2023;51(12):888–892.
2. Hallifax RJ, Goldacre R, Landray MJ, Rahman NM, Goldacre MJ. Trends in the incidence and recurrence of inpatient-treated spontaneous pneumothorax, 1968-2016. *JAMA*. 2018;320(14):1471–1480.
3. Chen Q, Huang G, Li T, *et al*. Insights into epidemiological trends of severe chest injuries: an analysis of age, period, and cohort from 1990 to 2019 using the Global Burden of Disease study 2019. *Scand J Trauma Resusc Emerg Med*. 2024;32(1):89.
4. Huo YR, Chan MV, Habib AR, Lui I, Ridley L. Pneumothorax rates in CT-guided lung biopsies: a comprehensive systematic review and meta-analysis of risk factors. *Br J Radiol*. 2020;93(1108):20190866.
5. Moreno B, Nemcek Jr AA. Pulmonary radiofrequency ablation complicated by tension pneumothorax. *Semin Intervent Radiol*. 2011;28(2):183–186.
6. George G, Aujayeb A. Cardiac-device implantation and pneumothorax—a symptom-based approach: experience from a district General Hospital. *Reports*. 2022;5(4).
7. Hodzic S, Golic D, Smajic J, Sijercic S, Umihanic S, Umihanic S. Complications related to insertion and use of central venous catheters (CVC). *Med Arch*. 2014;68(5):300–303.
8. Manhire A, Charig M, Clelland C, *et al*. Guidelines for radiologically guided lung biopsy. *Thorax*. 2003;58(11):920–936.
9. Ciriaco P, Muriana P, Lembo R, Carretta A, Negri G. Treatment of thoracic endometriosis syndrome: a meta-analysis and review. *Ann Thorac Surg*. 2022;113(1):324–336.
10. Nezhat C, Lindheim SR, Backhus L, *et al*. Thoracic endometriosis syndrome: a review of diagnosis and management. *JSLS*. 2019;23(3).
11. Anzueto A, Frutos-Vivar F, Esteban A, *et al*. Incidence, risk factors and outcome of barotrauma in mechanically ventilated patients. *Intensive Care Med*. 2004;30(4):612–619.
12. Siddiqui S, Falak U. Pneumothorax ex-vacuo or trapped lungs appearing as iatrogenic hydropneumothorax: A case report and review of non-expandable lungs (NEL). *Cureus*. 2023;15(7):e41814.
13. Rousset P, Gregory J, Rousset-Jablonski C, *et al*. MR diagnosis of diaphragmatic endometriosis. *Eur Radiol*. 2016;26(11):3968–3977.
14. Roberts ME, Rahman NM, Maskell NA, *et al*. British thoracic society guideline for pleural disease. *Thorax*. 2023;78:1143–1156.

15. Walker S, Hallifax R, Ricciardi S, *et al*. Joint ERS/EACTS/ESTS clinical practice guidelines on adults with spontaneous pneumothorax. *Eur Respir J*. 2024;63(5).
16. Brown SGA, Ball EL, Perrin K, *et al*. Conservative versus interventional treatment for spontaneous pneumothorax. *N Engl J Med*. 2020;382(5):405–415.
17. Hallifax RJ, McKeown E, Sivakumar P, *et al*. Ambulatory management of primary spontaneous pneumothorax: an open-label, randomised controlled trial. *Lancet*. 2020;396(10243):39–49.
18. Shafiq M, Banka R, Bain PA, Mahmood K, Rahman NM, Cheng G. Autologous blood patch for persistent air leak following secondary spontaneous pneumothorax: A systematic review. *J Bronchology Interv Pulmonol*. 2023;30(1):70–75.
19. Walker SP, Bibby AC, Halford P, Stadon L, White P, Maskell NA. Recurrence rates in primary spontaneous pneumothorax: a systematic review and meta-analysis. *Eur Respir J*. 2018;52(3).